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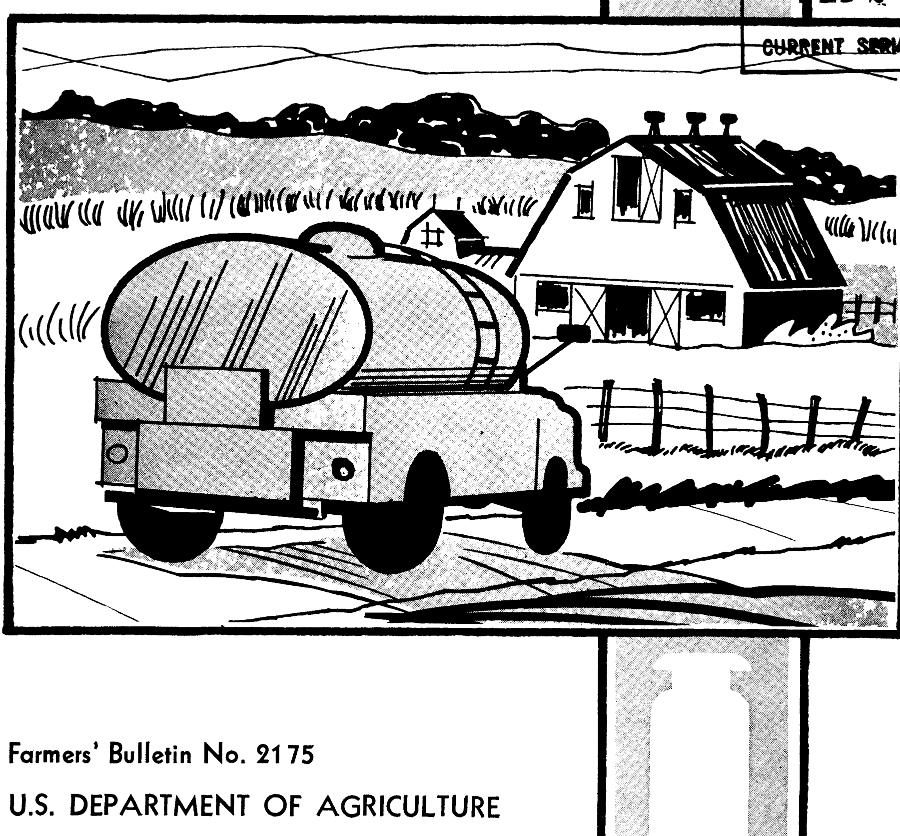
EQUIPMENT FOR COOLING MILK ON THE FARM



Farmers' Bulletin No. 2175

U.S. DEPARTMENT OF AGRICULTURE

REGULATIONS AND STANDARDS

Most communities regulate milk quality. In general, they use the Milk Ordinance and Code of 1953, Recommendations of the Public Health Service, U.S. Department of Health, Education, and Welfare. Basically this ordinance requires that milk for pasteurization be cooled to at least 50° F. unless it is delivered to a milk plant or receiving station within 2 hours after completion of milking.

A voluntary standard, the 3–A Sanitary Standard for Dairy Equipment, was developed by a group of sanitarians, equipment makers, dairy processors, and the U.S. Public Health Service. The 3–A standard pertains mainly to materials, construction, and finish of dairy equipment. For bulk milk tanks this standard requires:

- For the first milking, farm cooling tanks must be capable of cooling the amount of milk for which they are designed from 90° to 50° F. within 1 hour after the end of the loading period. The standard allows a loading period of 1½ hours; the compressor must be running during this time.
- The tank must then cool the milk from 50° to 40° F. within an additional hour.
- During the second or later milkings the cooling system must be capable of preventing the blend temperature of the milk in the tank from exceeding 50° F. when the previous milk has been cooled to 37°.

CONTENTS

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This bulletin supersedes Farmers' Bulletin 2079, "Farm Methods of Cooling Milk," and Farmers' Bulletin 1818, "Mechanical Milk Cooling on Farms."

Washington, D.C. Issued November 1961

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D.C. - Price 10 cents

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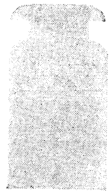


Fresh milk must be cooled promptly to retard bacterial growth. Milk normally contains few bacteria when it leaves the cow's udder. But no matter how carefully the milk is handled after it is drawn, additional bacteria may get in it. These bacteria come from the air, dust and dirt from the cow, and improperly cleaned and sanitized utensils.

Bacteria grow and multiply rapidly in warm milk. Although they may be harmless, bacteria soon cause souring or other undesirable changes. Milk temperature is about 95° F. when the milk leaves the udder. Bacteria grow rapidly at this temperature; if the milk is cooled to below 50°, bacteria growth is slower. At 40° and less, bacteria growth is still slower.

Freshly drawn milk has germicidal qualities that help retard bacteria for a short time after milking. If the milk is cooled properly after it is drawn, the germicidal qualities are prolonged.

BULK MILK TANKS

TYPES

Two types of bulk tanks are in general use—atmospheric and vacuum. The open bulk tank is called an atmospheric tank because atmospheric pressure exists both inside and out.

Atmospheric tanks are in general use and usually have large, top-opening lids. Many models are made low especially for convenience of pouring in milk by hand.

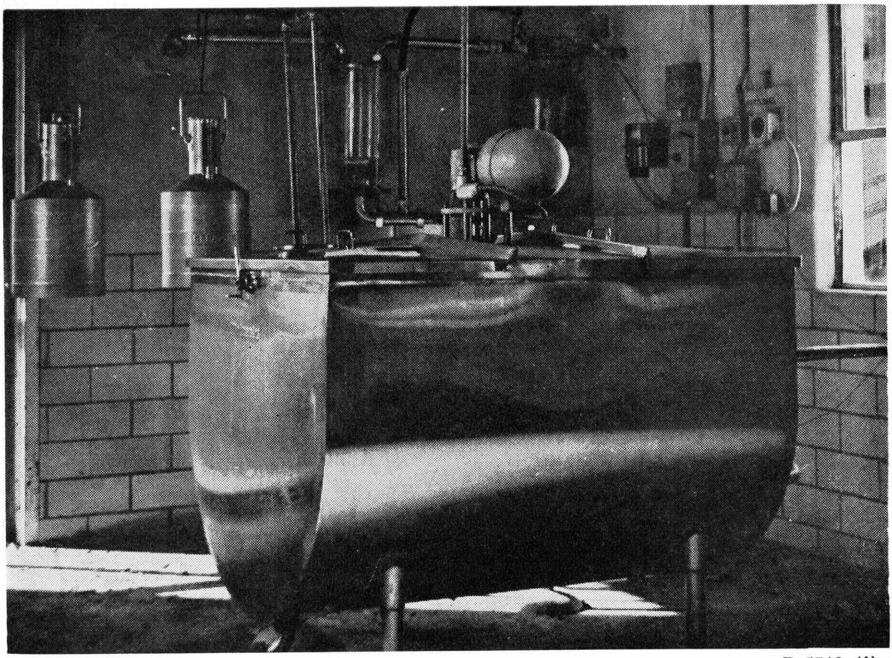
The vacuum tank is sealed during operation and is connected to the milking system. The milking machine vacuum pump maintains a partial vacuum inside the tank.

When a vacuum tank is used with a pipeline milking system, the milk is drawn directly into the tank without the aid of a releaser or pump. Milk cooled during milking is under vacuum. Milk can also be drawn directly into the tank from milk cans when the tank is under vacuum.

Vacuum tanks are cylindrical with small lids; this makes them difficult to clean. To overcome this difficulty, automatic cleaning systems have been developed.

SIZES

Select a tank that will provide a reserve capacity of at least 25 percent at peak daily production.



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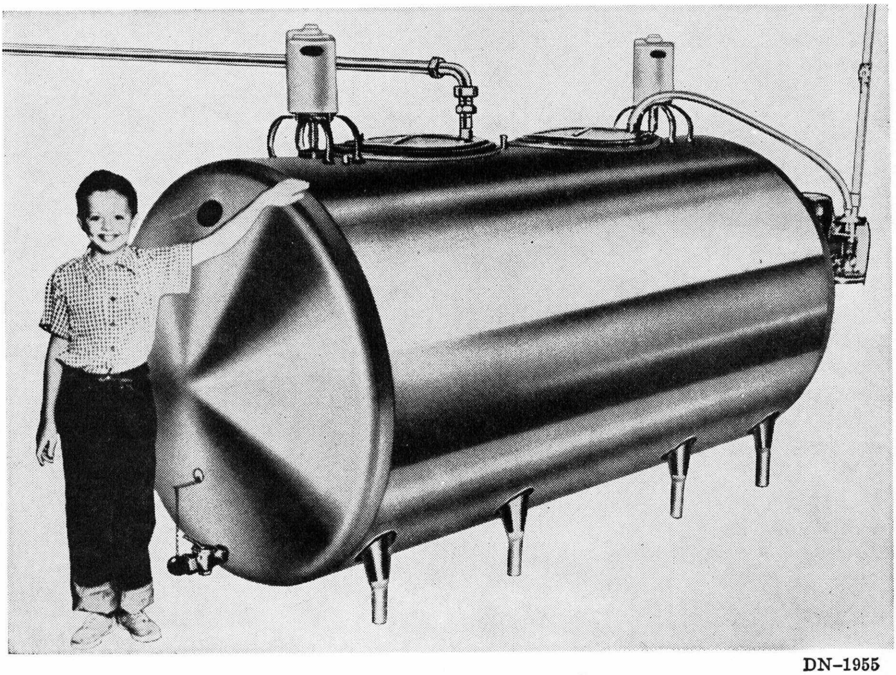
Atmospheric bulk milk tank.



DN–1955

Vacuum bulk milk tank.

This will allow future expansion, some change in pickup schedule, or reserve capacity in event of a truck failure or bad weather.

A farm that has peak production of 150 gallons a day should have a 400-gallon tank for every-other-day pickup. In winter months, production may be 75 percent of peak production, or 112.5 gallons per day. A 400-gallon tank will hold more than six milkings.

The size of your milkhouse may limit the length and the width of the tank you can install. Using a pipeline milker will allow you a choice among milk tanks of several shapes.

CONSTRUCTION

Exterior

The exterior walls of bulk tanks are of stainless steel, painted mild steel, plastic, or aluminum alloy. Because there are many different alloys of stainless steel, those used on the exteriors of tanks may differ. A stainless steel exterior remains in good condition for the life of the tank. Painted surfaces may need refinishing periodically. Maintaining a well-ventilated and heated milkhouse will reduce the need for refinishing painted, mild-steel tanks.

Painted mild-steel surfaces may chip and deteriorate. Corrosion may form underneath the paint where welds are made at junctions of different steels. Of course, painted steel tanks can be sand blasted and repainted.

Plastic has an advantage—chipped or damaged surfaces can be patched.

Interior

3–A standards require that interior parts that come in contact with milk or milk products be constructed of 18-8 stainless steel (about 18-percent chromium and 8-percent nickel). These parts include inside lining, covers, bridges, doors, agitators, inlet and outlet connections, measuring devices, and distributor, when used. The surfaces should be smooth and have rounded corners.

In many coolers, the milk liner is made of 16-gage stainless steel. Large tanks may be 14-gage; the heavier steel makes a strong, rigid tank less apt to change in calibration.

Insulation

Most bulk tanks need 2 or 3 inches of insulation. Mineral-wool or foamed-in-place insulation is used.

Mineral-wool insulation often becomes wet because of the moisture in the milkhouse and loses its insulating ability. Cold, refrigerated surfaces within the insulation cavity condense moisture drawn in from the milkhouse through any holes in the outside shell. Moisture will be absorbed unless the insulation is water-vapor resistant or hermetically sealed against any vapor moisture or air movement. Especially vulnerable are places of entry for refrigerant tubing, controls, and breather vents (used only during shipping).

The problem of moisture accumulation in insulation is not eliminated by leaving drain holes in the bottom of the outer tank. Moisture will not drain out until the insulation is saturated. Signs of wet or damp insulation are increased running time during warm weather and more than normal condensation on the tank exterior.

Tanks insulated with mineral wool should have the outside shell sealed against vapor penetration because drying or replacing wet insulation is difficult.

Foamed-in-place insulation that is water resistant aids in sealing against moisture any openings in the outside shell of the tank. Usually this insulation does not need replacement or drying.

REFRIGERATION SYSTEMS

Bulk milk tanks use either a direct-expansion method of cooling or the ice-bank method, also known as stored refrigeration.

Direct-expansion cooling requires a refrigerating unit two to three times as large as that of the ice-bank system; an ice-bank system requires a large ice reservoir. The refrigeration system builds up an ice-bank before milk cooling begins. Water from the melting ice bank is circulated on the outside of the tank's inner lining to cool the milk. A comparison of the two methods is shown in table 1.

REFRIGERATING UNITS

Types

The refrigerating unit includes the compressor, motor, condenser, and the attached controls. These controls are for motor starting, overload protecting, or water regulating (on a water-cooled condenser).

Compressors used on milk coolers are of three types:

- Sealed hermetic, in which the motor and compressor are completely enclosed in a welded assembly.
- Accessible hermetic, in which the compressor and motor are

TABLE 1.—*Comparison of two refrigeration systems*

Characteristics	Type of unit	
	Direct expansion	Ice bank
Total installed cost		Usually less, because of the smaller condensing unit, smaller electric service, and smaller wire and controls.
Energy	Slightly less total energy consumption at greater demand.	
Cooling performance	Depends on condensing unit capacity.	Depends on ice bank and circulating system design.
Size of condensing unit (minimum).	1 horsepower for each 50 gallons per milking (water-cooled). Increase 10 percent for air-cooled.	⅓ to ½ horsepower for each 50 gallons per milking.
Milkhouse heating (winter).	Heat released during cooling.	Heat given off over longer period following milking.
Milkhouse ventilation (summer).	Good ventilation essential when using air-cooled condenser—forced air in warm climates.	Good ventilation essential—forced air in warm climates.
Emergency operation	No cooling without electric standby generator.	Uses smaller standby generator. Some cooling possible with supply of cold water.
Milk freezing	Possible, especially when improperly operated or controlled.	Practically impossible.

in one unit that may be disassembled.

- Open compressor, in which the compressor is driven by a belt from the motor.

Three types of condensers are used—air cooled, water cooled, and combination air and water cooled.

Sizes

The size of the refrigerating unit needed depends on the operating conditions:

- Direct-expansion systems require 1 horsepower, for each 50 gallons of milk cooled, when used with a water-cooled or an air-cooled condenser in a mild climate.
- Ice-bank systems require ⅓ to ½ horsepower for each 50 gallons of milk cooled.

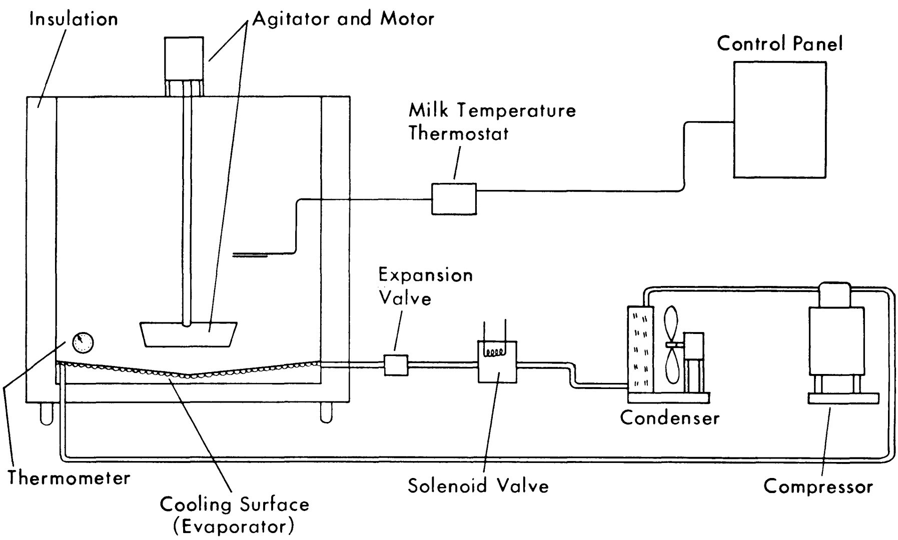
Condensing units usually are rated on their capacity to operate at a room temperature of 90° F. Even in mild climates, proper ventilation is necessary to prevent the milkhouse temperature from rising above 90°.

Installing an oversize condenser helps the compressor or condensing unit maintain its rated capacities in temperatures above 90° F. However, this is not a substitute for adequate ventilation.

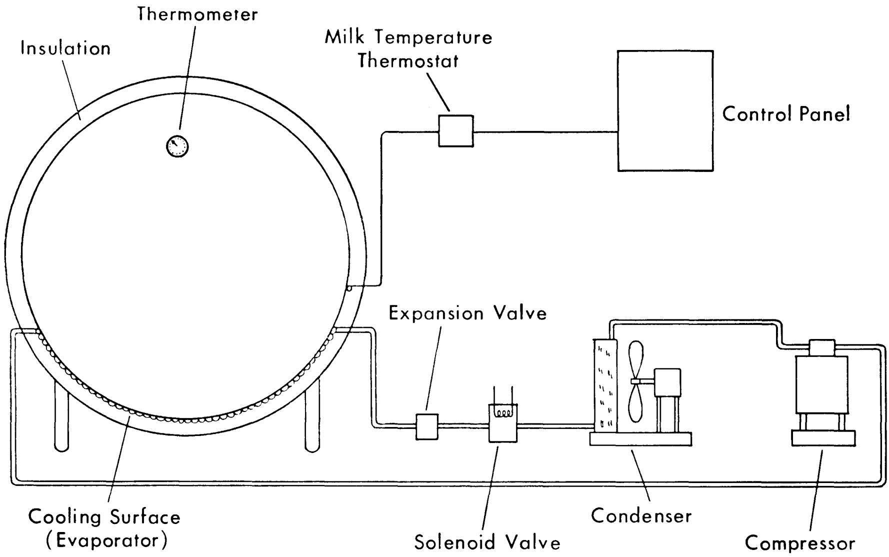
If, for some reason, a water-cooled condensing unit is not practical where summer temperatures are high, it may be practical to install an oversize, air-cooled condenser with a standard-size compressor. For example, a 5-horsepower condenser may be installed on a 3-horsepower compressor. Or, a 3-horsepower condenser may be installed on a 2-horsepower compressor.

Most condensing units are rated in B.t.u.'s under given operating conditions. The B.t.u., or British thermal unit, is a measurement of heat energy.

It is a simple matter to calculate how many B.t.u.'s will have to be removed from a given quantity of milk to cool it. However, the cooling capacity of a tank depends on its design and efficiency. Some milk tanks have a B.t.u. rating on their name plates. Without



Typical direct-expansion atmospheric tank system.



Typical direct-expansion vacuum tank system.

this rating, it is not possible to know the actual cooling capacity of the tank unless a specific test is made with the tank. A close estimate can be made if the average suction pressure is known. Table 2 gives minimum condensing unit sizes for different sizes of ice-bank and direct-expansion tanks.

Installing too small a condensing unit may not provide the required cooling capacity and often will result in serious overload conditions during the first milking.

If too large a condensing unit is installed on the tank, it will operate with lower than usual evaporator temperature. This has two disadvantages:

- The tank will be more apt to freeze milk.
- The reduced evaporator temperature will reduce the capacity and efficiency of the condensing unit.

TABLE 2.—*Guide for selecting condensing unit and bulk tank* [1]

Peak daily production	Condensing unit size		Tank size for pickup—		
	Direct expansion	Ice bank	Every day	Every other day	Every 3d day (3-day)
Pounds	*Horsepower*	*Horsepower*	*Gallons*	*Gallons*	*Gallons*
688	1	⅓	100	200	300
689 to 1,032	1½	½	150	300	450
1,033 to 1,375	2	¾	200	400	600
1,376 to 1,720	3	1	250	500	750
1,721 to 2,064	3	1	300	600	900
2,065 to 2,752	5	1½	400	800	1,200
2,753 to 3,440	5	2	500	1,000	1,500

[1] Tank size is based on peak production; it also allows for a 25-percent reserve.

In the evaporator, the refrigerant absorbs heat from the milk. Usually, the evaporator is on the bottom of the milk tank.

Motors are usually rated by horsepower. These ratings are frequently omitted from the compressor motor. Refrigeration units do, however, carry an ampere rating on their name plate. The ampere rating is an indication of the horsepower of the motor. The following list shows full-load amperes for 230-volt, single-phase motors:

HORSEPOWER:	*Amperes*
1	8
1½	10
2	12
3	17
5	28
7½	40

Ampere ratings of motors differ with operating voltages. Motors that will operate on two voltages (230 and 115) will have two ampere ratings. A motor operating at its low voltage rating uses twice the amperage needed to operate at the high voltage rating.

Wattage gives a true indication of the energy input for a motor. Some manufacturers in their technical literature give wattage ratings for refrigerating units under specific operating conditions.

Motor Protection

Small motors for fans and compressors up to 2 horsepower should have internal overheat protection. A notice about this protection will be found on the motor nameplate.

The protective-unit heater or time-delay type fuse should be equal or less than the ampere rating of the motor. This permits total overload of about 125 percent for short periods and continuous overload of 110 percent of the rating. One size less than nameplate rating will give better protection and will aid in preventing motor burnout.

Additional information on electric motors may be obtained from the U.S. Department of Agriculture, Washington 25, D.C.

Location

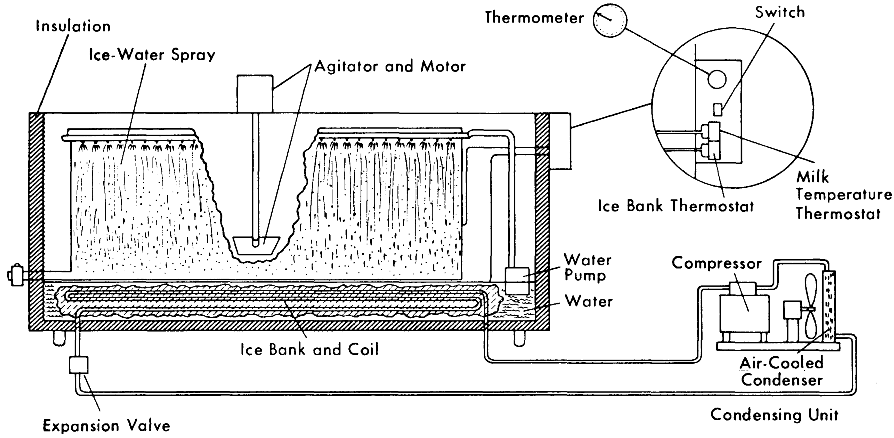
Where the condensing unit is located—inside the milkhouse or outside—depends on the type of condenser you have.[1]

- A water-cooled condenser may be located either outside or inside the milkhouse, but it should be protected from freezing in either location.
- An air-cooled condenser usually should be located near an outside wall so that outside air may be used to cool it. If the condensing unit is in the milkhouse, during warm weather you should provide an exhaust vent in the milkhouse wall so that the air, warmed by the condensing coils, can be discharged to the outside. During the winter you can close the vent and use this air to heat the milkhouse.

By using a circulating pump, water may be circulated through the water-cooled condenser and through tubing in the concrete floor to add heat to the floor of the milkhouse. A little heat added to the milkhouse floor, even though it may not be required for comfort, aids in drying the floor.

The circulating pump also may be used to move water from the condenser to a preheat tank, which supplies a regular water heater for use in washing milking equip-

[1] Regulations for location of different pieces of milk-cooling equipment and practices are not the same in every community. Local codes may be more strict than the Milk Ordinance and Code of 1953 and the 3-A Sanitary Standard for Dairy Equipment.



Typical ice-bank atmospheric tank system.

ment. A large part of the heat removed from the milk may be used, thus adding comfort and economy to the operation.

CONTROLS

A properly equipped milk cooler has controls for the operator's safety, for protection of equipment, and for operation.

These controls are—

- Fused electrical service to the milk cooler that comes directly from a fused safety switch or a fused panel for branch circuit protection.
- Thermal-overload protection devices on compressor motors that are equal to the ampere rating of the motor or 10 percent less.
- A control for the agitator so that its motor will not operate continuously unless milk is being cooled. Continuous operation without cooling may cause churning of the milk. On a direct-expansion system, the agitator motor should be wired to give interlock protection. With this protection, should the agitator or compressor stop, neither will operate. The milk in the tank will soon freeze if the compressor operates when the agitator is not operating.
- A sight glass installed in the liquid refrigerant line to allow you to check the refrigerant charge. A continuous flow of bubbles through the sight glass when the condensing unit is operating may be a sign of insufficient refrigerant.
- Oil separators installed in refrigeration systems to collect any oil that leaves the compressor with the refrigerant gas. The separator collects the oil and returns it to the crankcase of the compressor. In this way, oil is prevented from collecting in the evaporator where it can reduce capacity and efficiency. If oil collects in the evaporator, it can "slug back" and damage the compressor.

DIRECT-EXPANSION TANK CONTROLS

In direct-expansion systems, the two control systems generally used are indirect and direct thermostat control. For indirect control, a liquid-line solenoid valve controls the flow of refrigerant to the tank evaporator. The solenoid valve is controlled by the tank thermostat.

When refrigerant is admitted to the evaporator, it increases the pressure in the evaporator. This activates the compressor. The agi-

tator is usually wired in parallel with the solenoid valve.

When the tank is cooled to the temperature of the thermostat setting, the thermostat closes the liquid-line solenoid valve and stops the agitator. The compressor continues to operate until the evaporator is nearly emptied of refrigerant. The pressure control will then stop the compressor.

It is important that the low-side pressure control be properly set. A setting that is too low causes continuous operation of the compressor motor; a setting that is too high will not allow the motor to start at all. Improper differential or refrigerant leaks in valves or through the oil separator will cause frequent cycling.

Direct thermostat control has the thermostat controlling the compressor, agitator, and refrigerant solenoid valve.

ICE-BANK TANK CONTROLS

The amount of ice built by the refrigeration system is determined by an ice-bank control. A sensing element is mounted in the water close to an evaporation coil. The amount of ice built around the coil can be changed by moving the sensing element. When the ice-bank reaches the prescribed size, the ice-bank control shuts off the compressor motor.

Most compressors used on ice-bank cooling systems have built-in, thermal-overload devices to protect the compressor motor. If a tank was installed without an overload device, have one installed in each motor circuit.

When warm milk is in the tank, the water circulating pump should run when the agitator runs; otherwise churning may occur.

With a thermal-overload element sized for each motor, in a double-pole, single-throw, overload switch, overload protection is provided. Tripping of either element will stop both motors, thus giving full interlocking protection.

This device also is a manual switch. With it, you can turn off the agitator and circulator when the tank is empty. When this switch is on, operation is usually controlled by one thermostat that "senses" the temperature of the milk in the tank.

A set timer, wired in parallel with the thermostat gives manual control for the agitator and circulator. This manual control is used for:

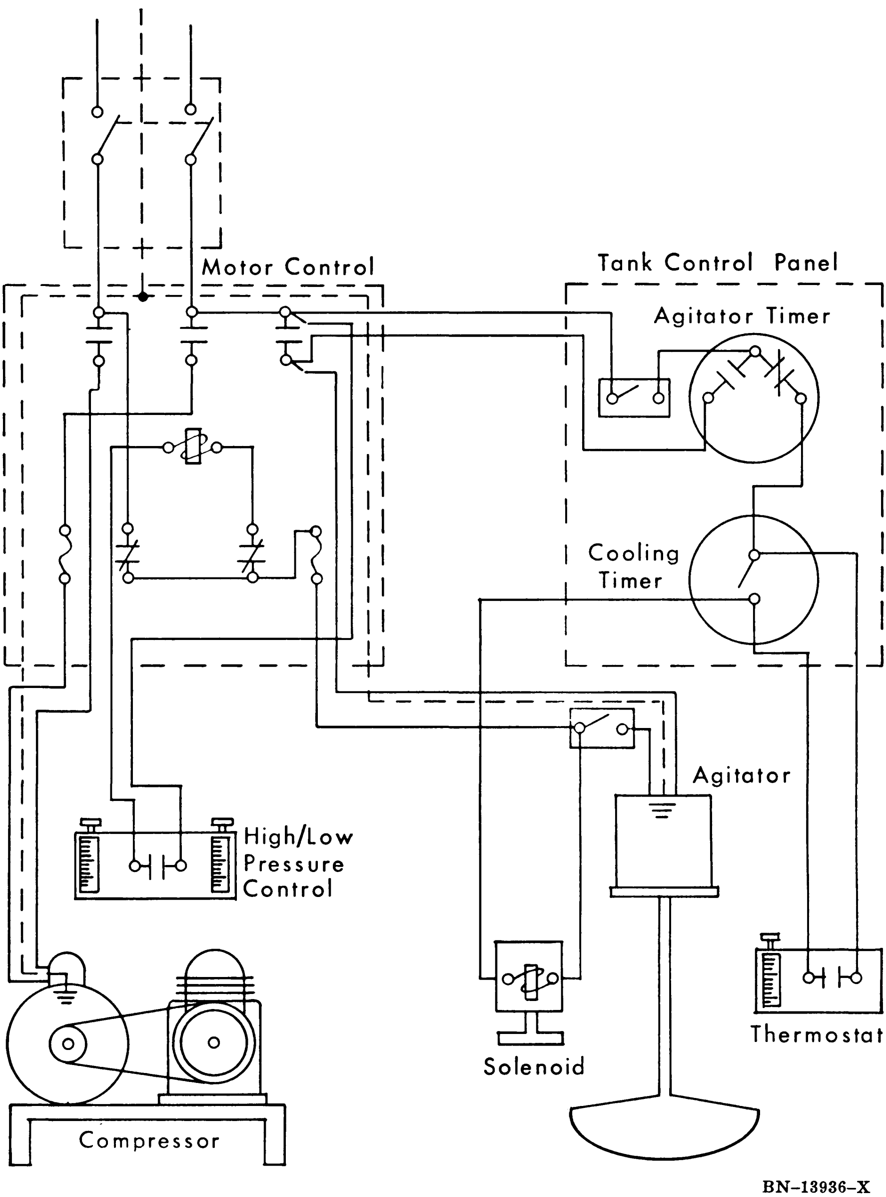
- Starting the agitator and water-circulating pump during first loading before the thermostat reaches its "cut-in" temperature.
- Starting the agitator and water-circulating pump before the second and subsequent loadings to blend the cream and milk and hasten cooling.
- Starting the agitator for mixing the milk before sampling.

In warm climates, once the milk has been cooled and the refrigeration system shut off, considerable temperature difference will develop when the milk is standing still. Temperatures higher than desirable may result in the top part of the milk. To avoid this, have an interval timer wired parallel to the thermostat and mechanical timer. Set the interval timer to operate the agitator 3 to 5 minutes every hour to keep the milk temperature uniform. This applies to both types of refrigeration systems.

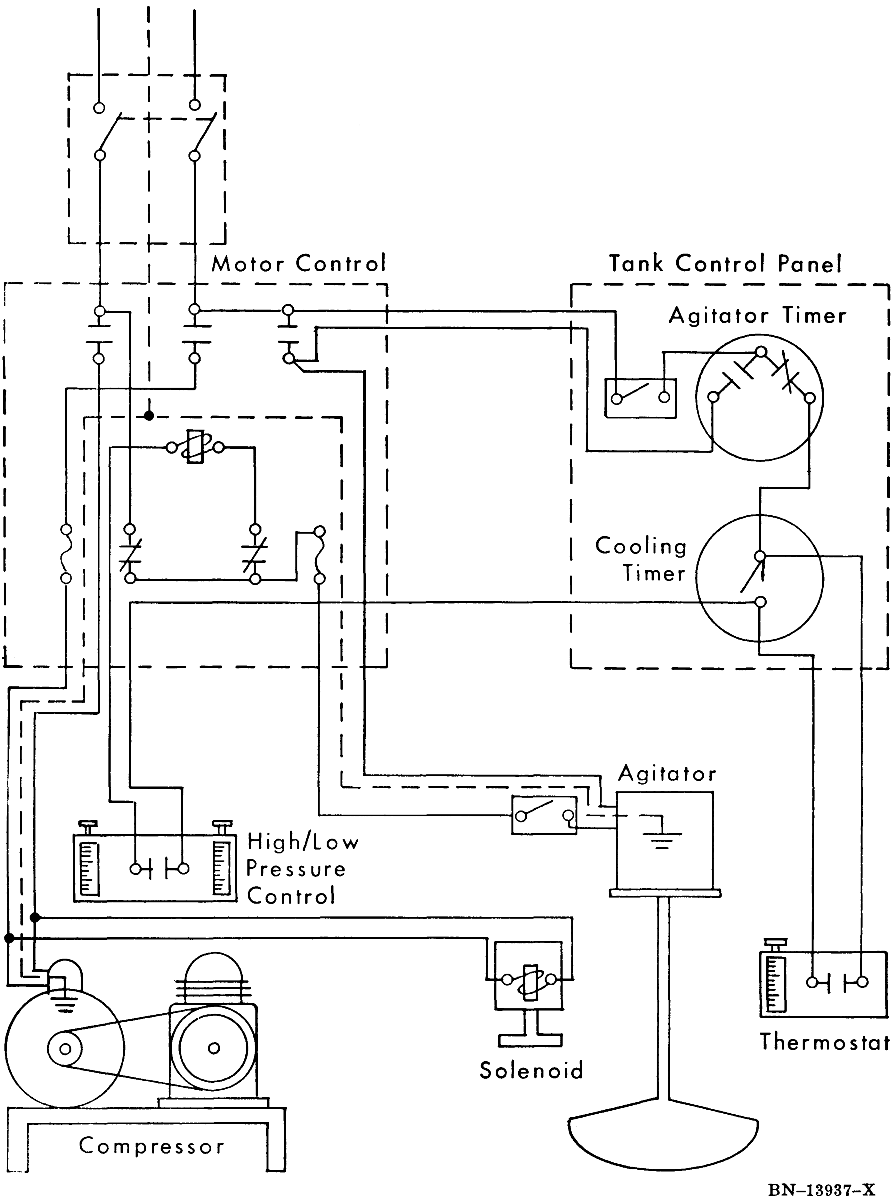
INSTALLATION

After you select the size and type of bulk milk cooler, consider carefully the installation of the tank, condensing unit, controls, and other milkhouse equipment.

Plans for remodeling or building a new milkhouse should be



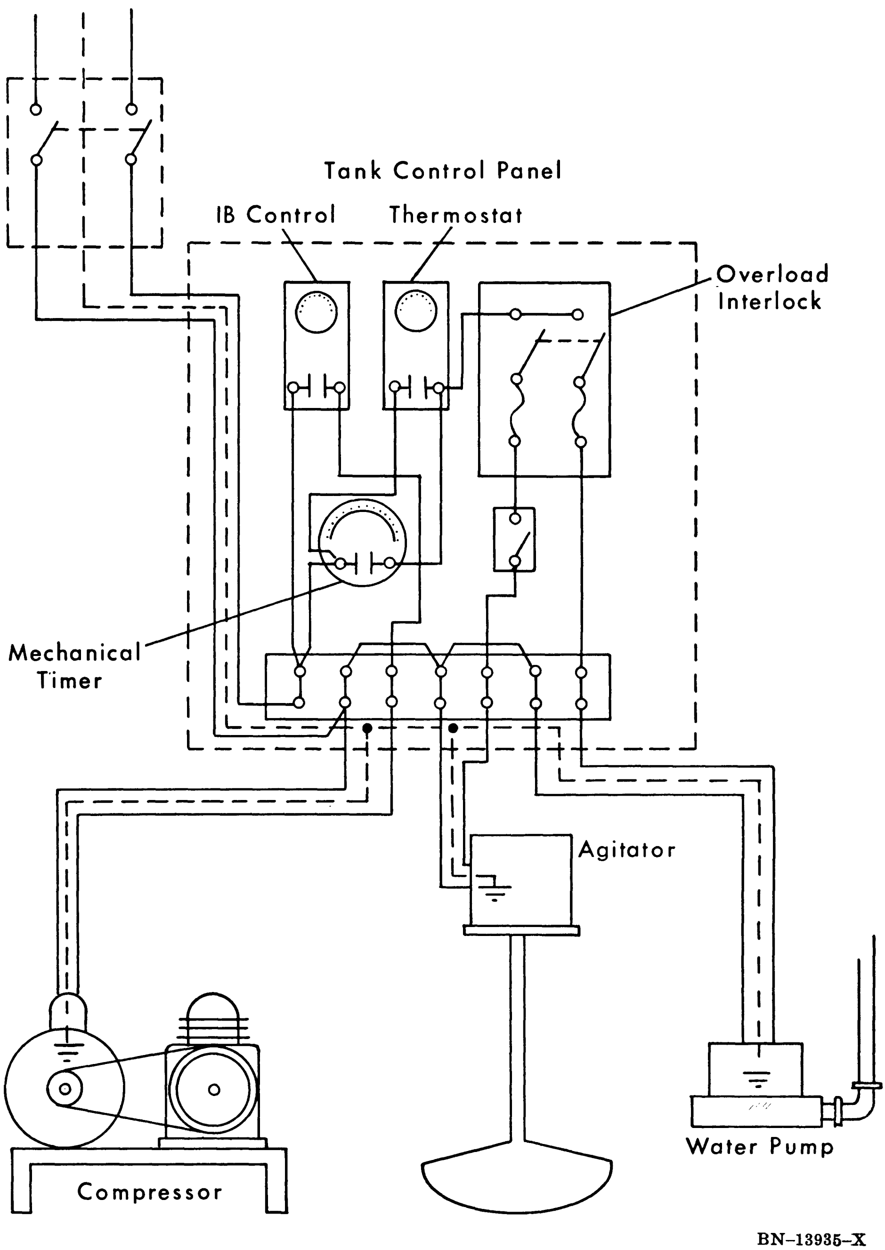
Wiring diagram for a milk tank with indirect thermostatic control—two-wire, 230 volts.



Wiring diagram for a milk tank with direct thermostatic control—two-wire, 230 volts.

approved by your milkplant representative, milk inspector, sanitarian, or other regulatory authority. Also check with your electric power supplier for wiring requirements.

Many persons have planned and built milkhouses without proper



Wiring diagram for an ice-bank tank—two-wire, 230 volts.

approval, only to find that the houses would not meet requirements.

The size of the milkhouse is important. Overall size depends on the equipment and its arrangement. Plan and leave space for everything you may want to include.

Most local ordinances require a space of at least 2 feet between the tank and the milkhouse walls or other equipment. Some ordinances require 3 feet of clearance on the outlet end, the side nearest the wash vat, and on the pour-in side. Be sure to place the tank outlet so that the pickup tank truck hose can reach it. Leave adequate room for washing facilities.

The milkhouse floor should have adequate slope for drainages—¼ to ½ inch per foot if the slope is uniform. One State university recommends a 5-inch concrete slab floor reinforced with No. 6, 6- by 6-inch wire mesh near the bottom of the slab. A heavy floor is necessary to prevent settling of the milk tank. Settling can cause a change in calibration of the tank.

Concrete pillars, extending below the frost line to support each leg, are sometimes used instead of a reinforced floor. Your county agricultural agent should have plans for constructing milkhouses.

If possible, electric wires, water lines, and refrigeration lines should not be placed directly over the tank. Light fixtures should be located so that the light will shine into the interior of the bulk tank without being located over the tank. Take care to avoid a glare that might hinder cleaning the tank.

Electric service outlets should be located conveniently for the operation of the milktruck pump. If located outside the milkhouse, a weatherproof outlet is required. Find out whether a 230- or a 115-volt outlet is needed. Also, check with your milkplant for the type of electric outlet required.

CALIBRATION AND MILK MEASUREMENT

Make sure your tank is calibrated by a person who is satisfactory to you and the milk receiver.[2]

In some areas of the United States, the factory calibration is accepted as the final calibration in the milkhouse. Under these circumstances an accurate level-indicating device must be provided with the tank. The tank is then leveled in the milkhouse from marks made at the factory. Some of the devices used for leveling are:

- Scribe marks on the inner tank for water level or scribe marks on the outer tank to lay a carpenter's level to.
- A circular spirit level and plumb bob marks.
- A piece of clear plastic hose containing water used with scribe marks.
- Bosses to place a carpenter's level on.

To insure that calibration is correct after installation, check the tank by measuring water with a certified can.

In some areas bulk tanks are calibrated after installation in the milkhouse. After these tanks have been calibrated in the milkhouse, the level indicator should be placed where any tank movement after installation can be recognized.

Measuring the quantity of milk in a bulk tank is done with a graduated rod, a liquid level indicator, or scales. A stainless steel rod graduated at 1/32- or 1/16-inch marks is the most common.

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[2]For local information on calibration consult the county sealer of weights and measures.

TANK OPERATION PROBLEMS

Normal Difficulties

Direct-expansion cooling systems are capable of freezing milk. Freezing usually occurs when the amount of milk in the tank is small. Freezing also is caused by improperly set or improperly functioning controls. If a large quantity of milk is frozen, it will jam the agitator and overload or burn out the agitator motor if not protected.

Overfilling an ice-bank container with water and improperly placing or setting controls could cause freezing that would buckle the tank liner. Permanent deformation of the tank liner would cause a change in calibration. An overflow pipe that works properly prevents overfilling of the ice-bank.

Emergency

For protection during a power failure, it is desirable to have a standby generator to operate a bulk milk cooler.[3]

Service

Determine what written warranty is available. Find out whether competent servicemen are available in your area.

Cost

Cost of operation is a complicated question and differs with the type of tank, how it is used, where it is used, climate, and how much maintenance is required.

Agitators are one source of repair expense. These range from grease leaks in the drive mechanism to motor burnout.

Repair of refrigerant leaks is a costly service. Other repairs result from motor failures that may be caused by improper fuse protection, wiring, controls, and overloading.

Direct-expansion coolers usually use slightly less electricity than ice-bank coolers to cool the same amount of milk. Direct-expansion coolers using a water-cooled condenser, or an air-cooled condenser in moderate temperatures, will cool 100 pounds of milk using less than 1 kilowatt-hour. Coolers with air-cooled condensers use more electricity in warm climates.

Ice-bank coolers that use an air-and-water-cooled condenser use more than 1 kilowatt hour per 100 pounds of milk cooled. Ice-bank coolers using air-cooled condensers use slightly more electricity. To offset the possible larger cost of operating ice-bank tanks, initial cost may be lower; also, compressor replacement cost will be lower because of the smaller size that is needed.

SURFACE COOLERS

The surface cooler usually is made either of two corrugated-metal sheets or of a continuous bank of tubes that form two corrugated surfaces. Milk flows down over the outer surface and a cooling liquid or gas flows upward inside the sheets or tubes. All surfaces that contact milk must be made of stainless steel.

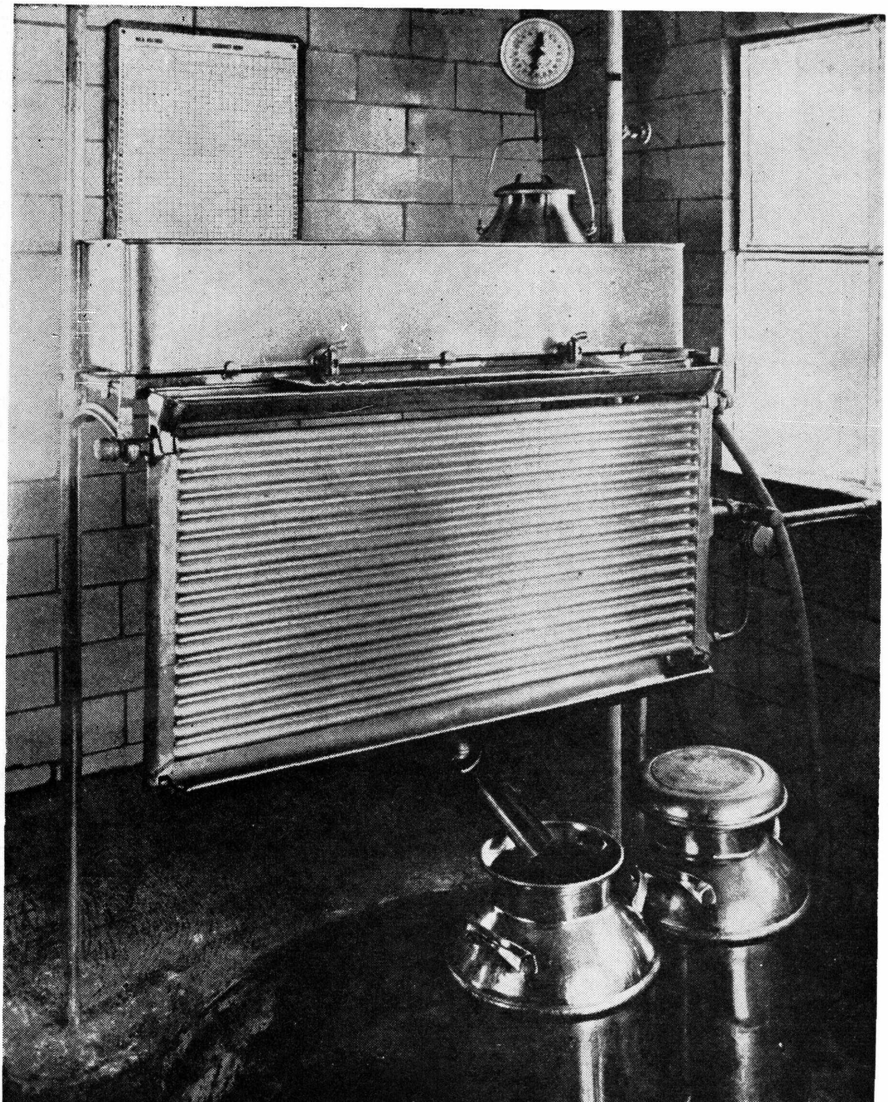
The cooling surfaces are in one or more sections. One arrangement is to have the top section connected with a water supply

[3]Information on standby electric power equipment may be obtained from your county agricultural agent or the U.S. Department of Agriculture, Washington 25, D.C.

and the bottom section connected with mechanically cooled water, cold brine, or a refrigerant gas. Using water in part of the surface cooler lowers refrigeration costs.

The size of surface cooler you need differs with the amount of milk to be cooled, the rate of milking, and the type of refrigerant. The manufacturer or dealer who supplies the cooler can tell you the size you need.

The surface cooler should be managed so that a continuous, thin film of milk flows over it. Controlling the flow of milk is especially important if the refrigerant is not mechanically cooled—



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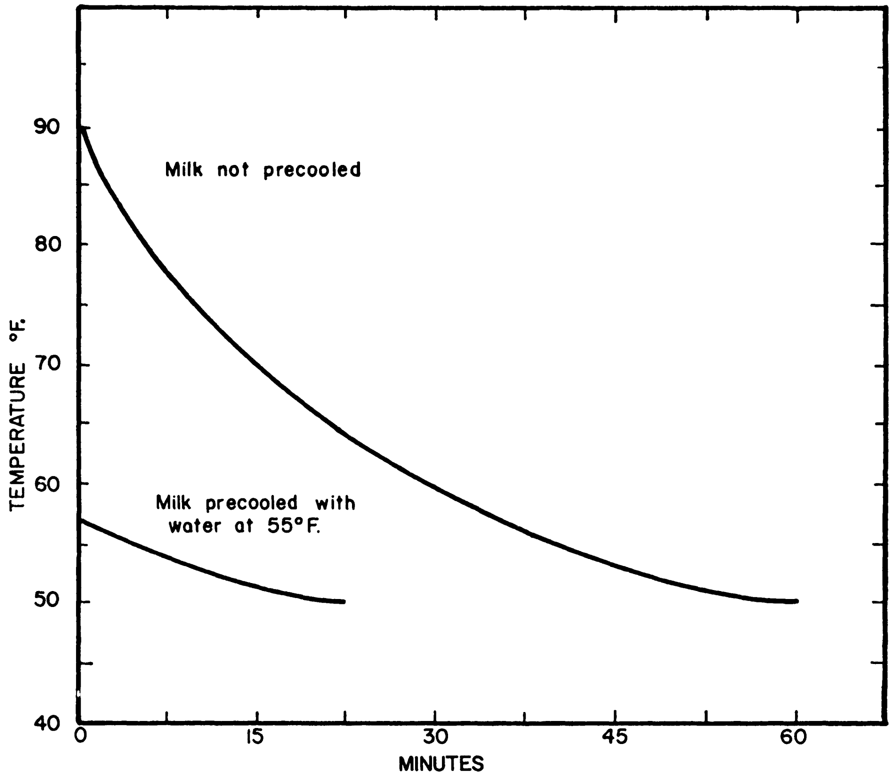
Surface cooler that has a water-cooled top section and a refrigerant-cooled bottom section.



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Comparative time required to cool milk in 10-gallon cans to 50° F. in tank water having an initial temperature of 37°, when the fresh warm milk has not been precooled and when it has been precooled by a surface cooler with water at 55°.

for instance, if cooling is done with well water.

Precooling milk over a surface cooler gives added protection to the milk by partial quick cooling and aerates it. This is most useful when the milk is cooled in a can cooler.

Prompt aeration of warm milk minimizes silage flavor and odor when the milk is only slightly tainted and reduces the degree of flavor and odor when the milk has a pronounced taint. To be effective, the milk must be precooled in a room where the air is clean, fresh, and free from dust and odors.

The milk from each cow should be precooled immediately after it is drawn, without waiting for all cows to be milked.

After the milk has been precooled, it must be stored at a low temperature until it is picked up by the processor. If the milk is precooled over a surface cooler with well water as the refrigerant, it usually will need further cooling during storage.

The surface cooler must be kept clean so that the bacterial count of the milk will be kept to an acceptably low number. To make cleaning easy, the cooler should be set out from the wall or away from cabinets or other equipment so that all sides can be easily reached.

CAN COOLERS

Can coolers are of two main types: immersion coolers and spray coolers.

IMMERSION COOLERS

For immersion cooling, cans of milk are placed in water up to their necks. The usual home-built immersion tank is made of concrete and usually is built as a part of the milkhouse.[4]

An immersion tank should be constructed so that it can be drained completely and cleaned easily. It should have a slat rack on the bottom to hold the cans off the bottom and allow the water to circulate under them.

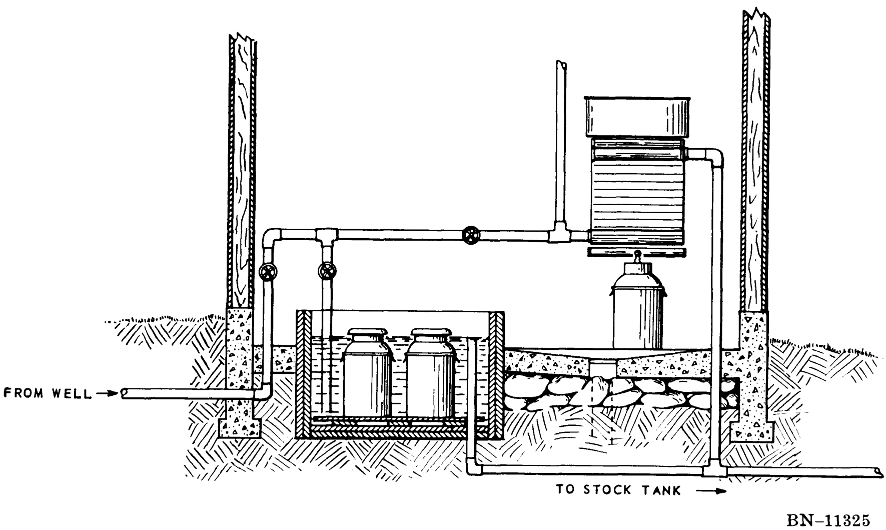
In most immersion tanks, the water is cooled by mechanical refrigeration. The refrigerant is circulated along the sides of the tank through metal coils submerged in the water. An ice bank develops around the coils during periods of light loads, to provide extra refrigeration for peak loads.

If mechanical refrigeration is not available, ice may be used to cool the water in immersion tanks. Ice should be put in the tank long enough before milking time to be sure the water is cold when the cans of warm milk are put in.

Enough ice should be used to cool the milk to 50° F. or below and hold it at that temperature. The greater the amount and the colder the water available per gallon of milk, the more effective is the cooling. For example, under average summer conditions, 30 gallons of water at an initial temperature of 37° will cool a 10-gallon can of milk from an initial temperature of 85° to about 50°. Twice as much water (60 gallons) at the same temperature will cool the same milk to about 47°.

For cooling milk with water, with or without ice, water may be pumped directly from the well to the surface cooler and to the wet-storage tank. Or, it may be drawn from a supply tank, if cold

[4]Plans for concrete storage tanks usually can be obtained from your county agricultural agent or State agricultural college.



A method of using the farm water supply to cool milk.

enough. Water from the supply tank should be used only during cold weather when it would be colder than the water pumped directly from a well.

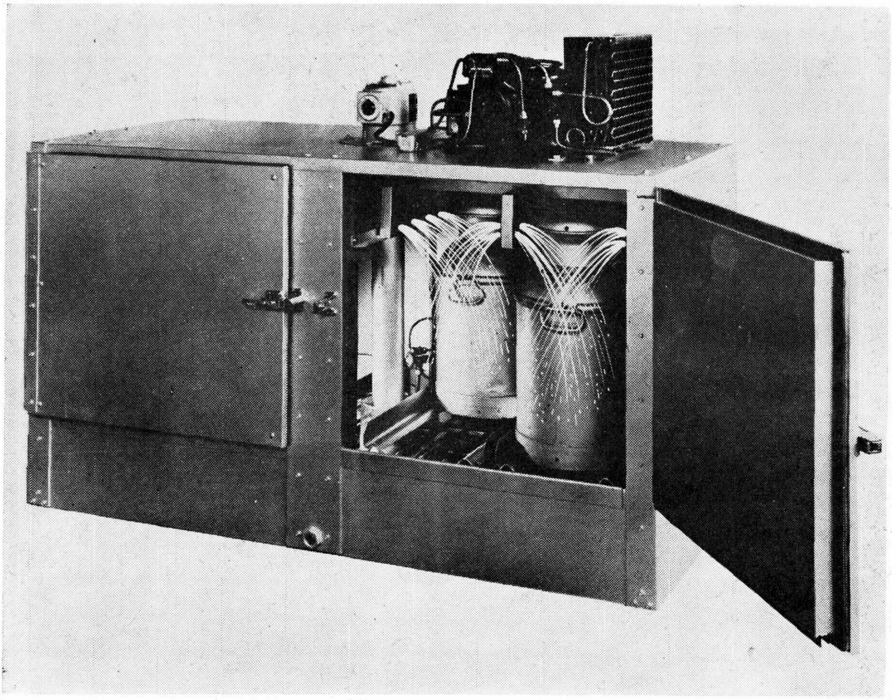
The inlet to the wet-storage tank should be at the bottom of the tank and the outlet near the top. Water flows around the cans, taking the heat from the milk. Then it can be pumped out to the stock tank, or to other use, from the overflow near the top.

The water in the tank must be kept moving to cool the milk in the shortest time. Different mechanical methods of agitation are:

- Forcing water through a tube from near the bottom of the tank to the top of the tank, and along its sides.
- Pumping cold water from the bottom of the tank through perforated pipes arranged lengthwise along each inner top side of the tank. One advantage of this method is that if the tank water is low, the cold spray hits the upper part of the cans.
- Forcing air through perforated pipes in the bottom of the tank. The rising air agitates the water.

SPRAY COOLERS

A spray can cooler usually is a cabinet with a side opening. Cold water is sprayed over the shoulders of the cans and flows down over them. These cabinets are effective and the side opening makes loading and unloading easy.



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A spray cooler. Cold water, pumped from the bottom, is sprayed over the shoulders of the cans.

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